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Environmental Assessment of an Active Oil Field in the Northwestern Gulf of Mexico 1977-1978. Volume 1. Synopsis

(U.S.) National Marine Fisheries Service, Galveston, TX

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William B. Jackson (Ed.)

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Southeast Fisheries Center

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16. ABSTRACT
The area selected for study is the operational Buccaneer Oil Field off Galveston, Texas. This field was selected because the field has been in production for about 15 years, it was isolated from other fields, it producted both oil and gas, and the Texas offshore area had not been fully developed but was expected to experience accelerated exploitation in the future. The objectives of the project are: (1) to identify and document the types and extent of biological, chemical and physical alterations of the marine ecosystem; (2) to determine specific pollutants, their quantity and effects; and (3) to develop the capability to describe and predict fate and effects of Buccaneer Oil Field contaminants. The project uses historical and new data and includes investigations both in the field and in the laboratory. It is anticipated that the results of this project will impact in a significant way on future decisions regarding operations of oil and gas fields on the outer continental shelf. (Sinha - OEIS)

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VOLUME 1 - SYNOPSIS

A report to the Environmental Protection Agency on work conducted under provisions of Interagency Agreement EPA-IAG-D5-E693-EO During 1977-1978

EDITOR

William B. Jackson
Senior Specialist
Environmental Research Division

National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service(NMFS)
Southeast Fisheries Center
Galveston Laboratory
4700 Avenue U
Galveston, Texas 77550

1979

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PROJECT ADMINISTRATION

Contract Officer's Technical Representative

Edward F. Klima, Ph.D.
Director
Galveston Laboratory

Project Manager

Charles W. Caillouet, Ph.D.
Chief, Environmental Research Division

Project Staff

David C. Simmons
Senior Specialist
Field Operations and Logistics

William B. Jackson
Senior Specialist
Contracts and Deliverables

Petronila C. Prado
Clerk-Stenographer

Gregg R. Gitschlag
Oceanographer

Gary M. Faw
Fishery Biologist

Helen L. Tejeda
Clerk Typist

Nanette G. Johnson
Clerk Typist

GUIDE TO USERS

This Annual Report is printed in three separate volumes:

Volume I - Synopsis

Volume II - Data Management and Biological investigations

Volume III - Physical and Chemical Investigations

Volume I is designed to be used as a briefing document and as a key to more detailed scientific and technical information contained in Volumes II and III. Objectives, methods and results for each work unit are summarized in greatly abbreviated form within Volume I to facilitate dissemination of information. Thus, Volume I can be used alone or as a reference to companion Volumes II and III. Complete citations for literature cited in Volume I can be found in the Volumes II or III in which the detailed work unit reports are presented.

It is hoped that such an approach to environmental impact information dissemination will make the Annual Report a more useful and widely read document.

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FOREWORD

Increased development of the Federal outer continental shelf (OCS) in the Gulf of Mexico is expected as the U. S. attempts to reduce its dependency on foreign energy supplies. To obtain information concerning the environmental consequences of such development, the Federal Government is supporting major research efforts on the OCS to document environmental conditions before, during, and after oil and gas exploration, production, and transmission. Among these efforts is the Environmental Assessment of the Buccaneer Oil and Gas Field in the Northwestern Gulf of Mexico, a project funded by the Environmental Protection Agency (EPA) through interagency agreement with the National Oceanic and Atmospheric Administration (NOAA) and managed by the National Marine Fisheries Service (NMFS), Southeast Fisheries Center (SEFC), Galveston Laboratory in Galveston, Texas. Initiated in 1975, it was planned as a 5-year project which is now in its third year. Its major products are annual reports of findings, which are disseminated by the National Technical Information Service, data files disseminated by the Environmental Data and Information Service, and research papers written by participating investigators and published in scientific journals. Results are also made available through EPA/NOAA/NMFS project reviews, workshops and conferences attended by project participants, and various governmental, private, and public user groups.

Objectives of the project are (1) to identify and document the types and extent of biological, chemical and physical alterations of the marine ecosystem associated with Buccaneer Oil Field, (2) to determine specific pollutants, their quantity and effects, and (3) to develop the capability to describe and predict fate and effects of Buccaneer Oil Field contaminants. The project uses historical and new data and includes investigations both in the field and in the laboratory. A brief Pilot Study was conducted in the fall and winter of 1975-76, followed by an extensive survey in 1976-77 comparing the Buccaneer Oil Field area with adjacent undeveloped or control areas. In 1977-78, investigations were intensified within Buccaneer Oil Field, comparing conditions around production platforms, which release various effluents including produced brine, with those around satellite structures (well jackets) which release no

effluents. Third-year studies around Buccaneer Oil Field structures are focusing on (1) determining concentrations and effects of pollutants in major components of the marine ecosystem, including seawater, surficial sediments, suspended particulate matter, fouling community, bacterial community, and fishes and macro-crustaceans, (2) effects of circulation dynamics and hydrography on distribution of pollutants, and (3) mathematical modeling to describe and predict sources, fate and effects of pollutants.

This project has provided a unique opportunity for continued study of effects of chronic, low-level contamination of the marine ecosystem associated with oil and gas production in an established field. In many respects, it represents a pioneering effort. It has been made possible through the cooperation of government agencies, Shell Oil Company (which owns and operates the field) and various contractors including universities and private companies. It is anticipated that the results of this project will impact in a significant way on future decisions regarding operations of oil and gas fields on the OCS.

Charles W. Caillouet, Project Manager
Chief, Environmental Research Division
NOAA/NMFS/SEFC/Galveston Laboratory
Galveston, Texas

CONTRIBUTORS

Volume I - SYNOPSIS
NMFS/SEFC Galveston Laboratory
W. B. Jackson (Editor)

Volume II - DATA MANAGEMENT AND BIOLOGICAL INVESTIGATIONS

Task 2.2

Work Unit 2.2.3 NMFS/SEFC National Fisheries Engineering Laboratory

K. Savastano
H. Holley

Task 2.3

Work Unit 2.3.4 NMFS/SEFC Galveston Laboratory

Z. P. Zein-Eldin
P. M. Keney

Work Unit 2.3.5 NMFS/SEFC Galveston Laboratory

I. K. Workman
C. E. Jones

Work Unit 2.3.6 NMFS/SEFC Panama City Laboratory

J. H. Finucane
L. A. Collins
L. E. Barger

Work Unit 2.3.7 University of Houston

R. K. Sizemore, Ph.D.
S. J. Hollaway
G. M. Faw

Work Unit 2.3.8 LGL, Ecological Research Associates

B. J. Gallaway, Ph.D.
M. F. Johnson, Ph.D.
R. L. Howard
L. R. Martin
G. S. Boland

Task 2.5

Work Unit 2.5.1 LGL, Ecological Research Associates

B. J. Gallaway, Ph.D.
F. J. Margraf, Ph.D.

VOLUME III - CHEMICAL AND PHYSICAL INVESTIGATIONS

Task 2.3

Work Unit 2.3.2/2.4.2 Rice University

J. B. Anderson, Ph.D.
R. R. Schwarzer, Ph.D.

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CONTRIBUTORS (continued)

Work Unit 2.3.9 NMFS/NEFC Atlantic Environmental Group
Narragansett Laboratory

R. Armstrong

Task 2.4

Work Unit 2.4.1 University of Houston

B. S. Middleditch, Ph.D.
B. Basile

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Dissertation and Theses Based Upon Buccaneer Oil Field Research:

Brenda Basile, Ph.D. Dissertation, University of Houston, 1978. Environmental Effects of Offshore Oil Production.

Evelyn S. Chang, M. S. Thesis, University of Houston, 1978. Sterols in the Marine Food Web.

INTRODUCTION

Location of Study Area

The area selected for study is the operational Buccaneer Oil Field located approximately 49.6 kilometers (26.8) nautical miles), from the Galveston Sea Buoy south southeast to production platform 296-B off Galveston, Texas (Figure 1). This field was selected as the study area because: (a) the field had been in production for about 15 years, which time had allowed full development of the oil-field-associated marine communties; (b) it was isolated from other fields which facilitated the selection of an unaltered area (for comparison) within a reasonable distance of the field; (c) it produced both oil and gas that represented a major portion of the pollutants from marine mineral extraction; (d) its location simplified logistics and reduced the cost of the research; and (e) the Texas offshore area had not been fully developed for gas and oil production but was expected to experience accelerated exploitation in the future.

Oil Field Operation History

The Buccaneer Oil Field was developed by the Shell Oil Company in four blocks of land that were leased in 1960 and 1968 as follows:

Year	Lease Number	Block Number	Acreage	Hectares
1960	G0709	288	2,790	1,129
1960	G0713	295	4,770	1,930
1960	G0714	296	4,501	1,821
1968	G1783	289	2,610	1,056

In the development of the field, 17 structures have been built; two are production platforms, two are quarters platforms, and 13 are satellite structures surrounding well jackets. Initial exploratory drilling began about mid-summer of 1960 with mobile drilling rigs. When (as the result of the exploratory drilling) the proper locations for platforms were selected, permanent platforms were constructed.

There has been no reported history of major oil spills from this field. Although there undoubtedly have been losses of from a barrel of oil upward because of the mechanical failure of various pieces of equipment, there have been no major oil spills, the largest spill being three barrels in 1973. The reported oil spill chronology and quantity for Buccaneer Field was as follows:

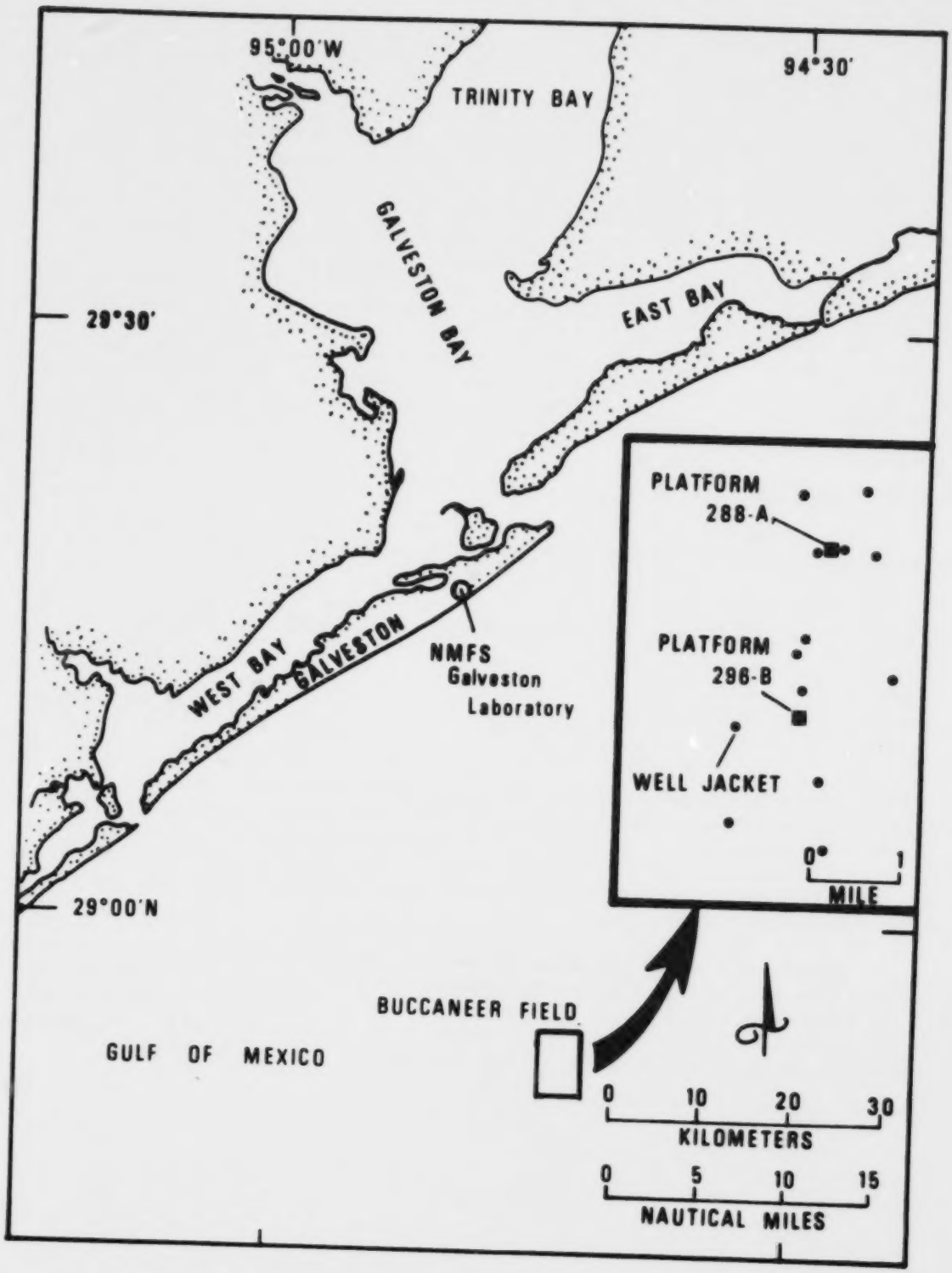

FIGURE 1. LOCATION OF BUCCANEER OIL FIELD

Date	Source	Amount	
		Barrels	Liters
September 1973	Platform 296-B	0.5	79
November 1973	Unknown	3.0	477
July 1974	Platform 296-B	0.5	79
August 1974	Platform 296-B	1.7	265
September 1975	Platform 288-A	0.2-0.4	38-56
Totals		5.9-6.1	938-956

The Buccaneer Oil Field first began operations with the production of oil. Later, when significant quantities of gas were found, the field began producing both oil and gas and has continued to do so to date.

The production platforms and satellites (well jackets) are connected by a number of pipelines with a 20-inch diameter main pipeline connecting the field to shore. All of the pipelines that are 10 inches or greater in diameter are buried. The Blue Dolphin Pipeline Company was granted a pipeline permit (No. G1381, Blocks 288 and 296) in 1965 and has operated the pipeline since its construction.

The Buccaneer Oil Field occupies a limited area (about 59.3 km^2; 22.9 sq. statute miles) leased in the northwestern Gulf of Mexico. Because of the geographically small size of this area and because major environmental similarities occur over much of the western Gulf of Mexico, it is anticipated that the results of the proposed studies can be extrapolated, to some extent, to other areas off the Texas coast where oil fields occur or will be developed in the foreseeable future.

Four types of structures located in Buccaneer Oil Field (production platform, quarters platform, satellite (well) jacket, and flare stack), to be referred to in this report, are shown in Figure 2, which is an oblique aerial photograph of production platform 288-A and vicinity within Buccaneer Oil Field. A map of Buccaneer Oil Field, (Figure 3) depicts the locations of platforms and satellite jackets within the field. Table 1 is a key to designations used by each work unit and by Shell Oil Company for these locations.

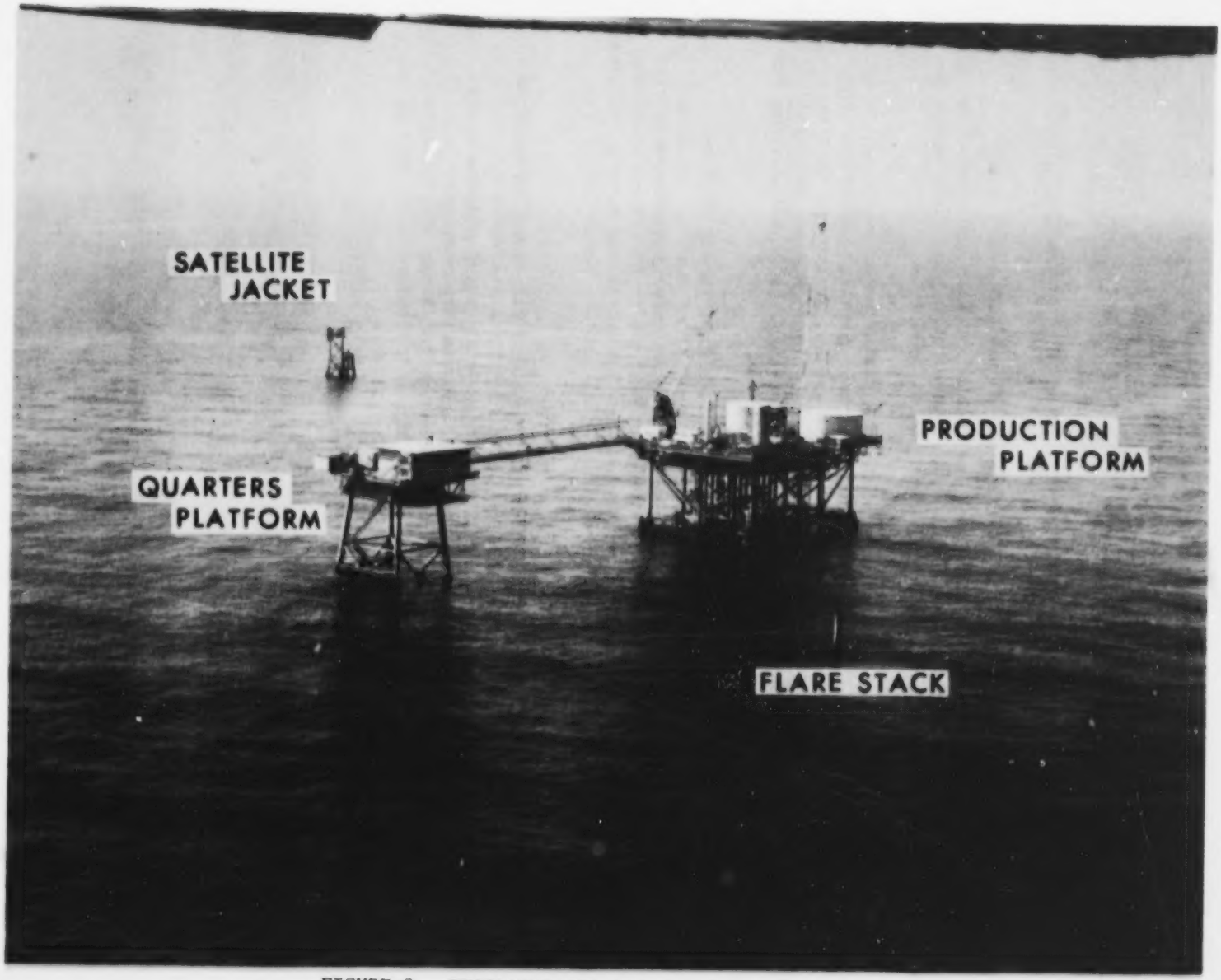

FIGURE 2. BUCCANEER OIL FIELD STRUCTURES

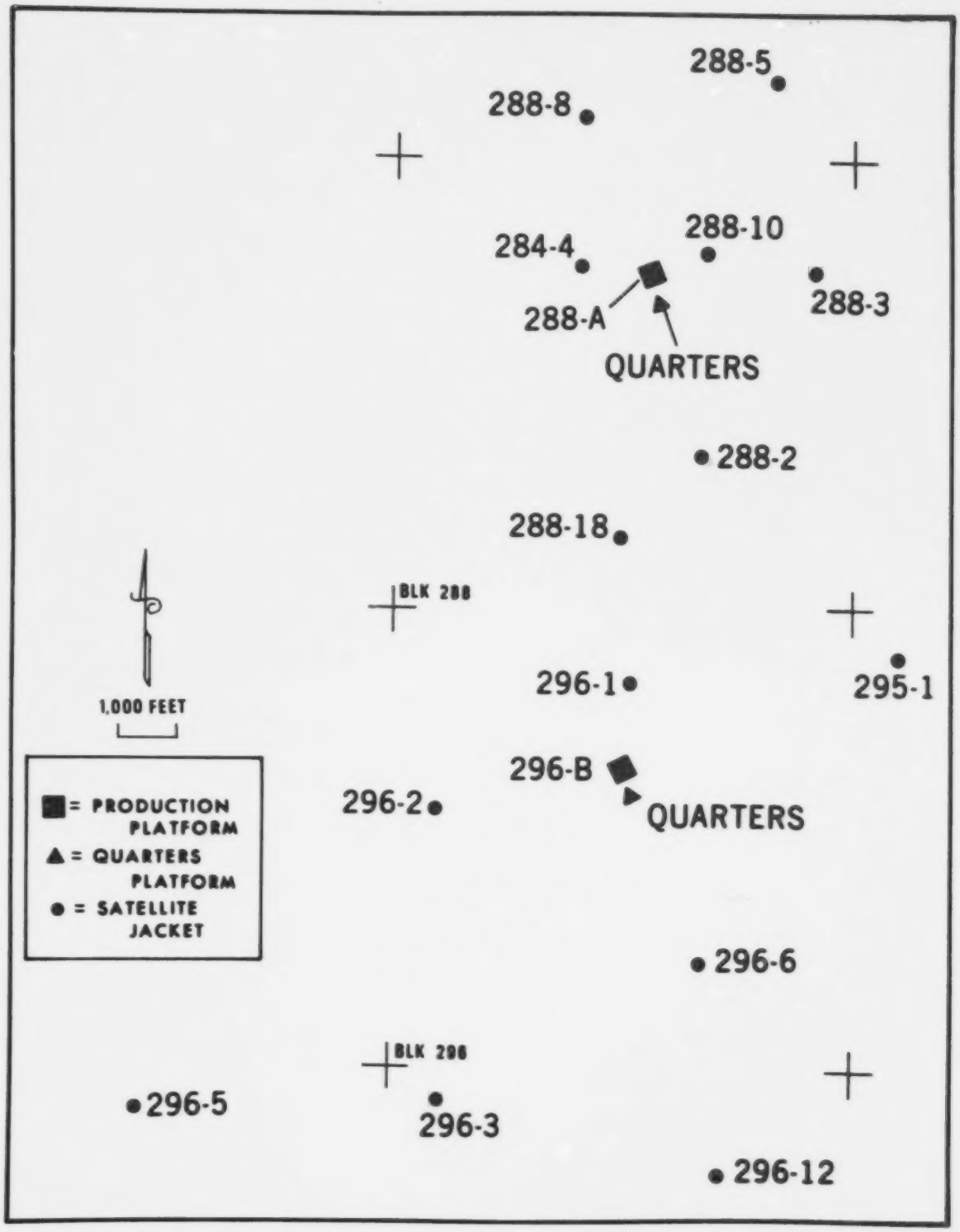

FIGURE 3. SHELL OIL COMPANY'S ALPHANUMERICAL IDENTIFICATION OF BUCCANEER OIL FIELD STRUCTURES

TABLE 1. PLATFORM AND SATELLITE KEY: 1977-1978

Shell Oil Company	WORK UNITS 2.3.2/ 2.4.2	2.3.4	2.3.5	2.3.6	2.3.7	2.3.8	2.4.1
Platform 288-A	Platform A or A	Platform A	Platform A or A	Platform "A"	Platform A	Production Platform & Quarters 288-A	pfm A
Platform 296-B	Platform B or B	Platform B	Platform B or B	Platform "B"	Platform B	Production Platform & Quarters 296-B	pfm B
Satellite Jacket 288-8							jkt A
Satellite Jacket 288-5			Control 288-5, C or Well Jacket 288-5			Satellite 288-5 or Satellite	jkt B
Satellite Jacket 288-4							jkt C
Satellite Jacket 288-10							jkt E
Satellite Jacket 288-3	Satellite Structure S						jkt F
Satellite Jacket 288-2							jkt G
Satellite Jacket 288-18				Satellite "N"			jkt H
Satellite Jacket 296-1			Control 296-1 or Well Jacket 296-1				jkt I
Satellite Jacket 295-1			Control 295-1 or Well Jacket 295-1				jkt J
Satellite Jacket 296-2				Satellite "g"			jkt K
Satellite Jacket 296-3							jkt M
Satellite Jacket 296-12							jkt M
Satellite Jacket 296-6							jkt O

Summary of Results by Work Unit

Task 2.3

Identify and Document the Extent and Types of Biological, Chemical, and Physical Alterations in a Marine Ecosystem that are Associated with the Development of and Production of Discharges from an Oil Field.

WORK UNIT 2.3.2/2.4.2 - DESCRIBE THE FINE SEDIMENTS AND NEPHELOID LAYER OF THE OIL FIELD, FOCUSING UPON THEIR RELATIONSHIP TO HEAVY METAL ADSORPTION/DETERMINE LEVELS, PATHWAYS, AND BIOACCUMULATION OF HEAVY METALS IN THE MARINE ECOSYSTEM IN THE OIL FIELD

PART A

Rice University

J. B. Anderson, Ph.D.
R. B. Wheeler

PART B

Texas Southern University

R. R. Schwarzer, Ph.D.

PART C

Texas Southern University

C. L. Hokanson

OBJECTIVES

PART A

1. Conduct sediment size and geochemical analyses of additional sediment samples taken near Production Platform 288-A and well jacket 288-3.

2. Perform suspended sediment geochemistry and dynamics within and around the Buccaneer Oil Field (BOF).

PART B

1. Document trace metal concentrations in surficial sediments, suspended sediments, and produced brine.

2. Compare the trace metal concentrations in surficial sediments and suspended sediments within BOF to those in unaltered areas.

3. Determine if trace metal concentration gradients exist in the surficial sediments around the structures within BOF.

4. Determine the concentrations of trace metals in subsurface sediments.

5. Identify the possible sources of those trace metals found to be present in concentrations greater than expected for an unaltered area.

PART C

1. Determine trace metals composition of the fouling community.

2. Determine trace metals composition of the infauna.

3 Determine trace metals composition of the fish that live in close proximity to oil field structures.

MATERIALS AND METHODS

PART A

1. Bottom samples were obtained by gravity corer.

2. Suspended sediments were collected using sediment traps.

3. Sediment size analyses were performed with the Rice University automated sediment analyzer (RUASA) for the same size (-1.0 to 4.0 ø) particles and coarse silt (4.0 to 6.0 ø) particles, and with the Rice University hydrophotometer for particle sizes in the 6.0 to 9.0 ø range.

4. Routine statistical output of the above system includes percent gravel, sand, silt, and clay; frequency and cumulative weight percents; mean grain size, standard deviation, skewness and kurtosis; and digital graphic displays of frequency and cumulative size distribution curves.

5. The mean grain size and standard deviation were computed by the method of moments (Folk, 1968).

6. Sediment cores taken in the vicinity of platform 288-A and well jacket 288-5 were used to measure the areal extent of scour zones and the depth of scouring.

PARTS B AND C

1. Trace metal analyses were accomplished using a Perkin-Elmer Model 360 atomic adsorption spectrophotometer equipped with a deuterium arc background correction system.

2. Single element hollow cathode lamps and an air-acetylene flame were used for all elements except Ba and Hg.

3. Ba analyses were conducted using a nitrous oxide-acetylene flame.

4. Hg was analyzed by flameless atomic adsorption using a Perkin-Elmer mercury analysis system.

5. All solvents and reagents were analyzed to determine the levels of possible contaminants and procedural blanks were analyzed following the same experimental techniques used in sample analysis.

6. Analytical error was estimated by analyzing a given sample solution a number of times for the same element.

7. Sampling error was estimated by analyzing several aliquots of the same homogenized sample.

RESULTS AND CONSLUSIONS

PART A

1. Bottom sediments in Buccaneer Oil Field (BOF) consist of relict calcareous shell hash, silts and clays of the Beaumont Formation, and sands dominated by a strong 3.5 ø fraction.

2. Surficial sediment deposits in BOF show considerable textural variability.

3. The greatest textural and compositional variability occur within approximately 60-m of production platforms.

4. Substantial amounts of organic debris are shed from the structures.

5. Periodic resuspension results in large concentrations of mineral debris within the lower part of the water column.

6. The Pleistocene Beaumont Formation exposed in the eastern portion of the study area has a distinct trace metal geochemistry compared to the overlying muddy sands which cover most of BOF.

PART B AND C

7. Surficial sediments contain significantly higher concentrations of Ba, Pb, Sr, and Zn than do subsurface sediments.

8. Mercury (Hg) appears to be somewhat enriched in surficial sediments as compared to subsurface sediments.

9. Comparing the surficial sediments from BOF with the average trace metal concentrations of surficial sediments from the Bureau of Land indicates that surficial sediments within 180-m of the two BOF production platforms contain significantly higher concentrations of Ba, Pb, and Zn than in the STOCS area (Sr and Hg were not determined in the BLM study).

10. Trace metal concentrations of subsurface sediments collected at depths of 12-20 cm are probably representative of background values before anthropogenic contributions.

11. Increased turbulence created by the structures causes material to remain suspended or to be resuspended and deposited on the western (downcurrent) side of the structures.

12. Pieces of corroded metal are constantly being removed from the structures and are accumulating in the surficial sediments.

PART B AND C

13. Suspended sediments collected by sediment traps beneath production platform 288-A have higher average concentrations of Cr, Cu, Ni, and Zn than do surficial sediments collected near the structures by piston cores.

14. Surficial sediments within 180-m of production platform 288-A contain greater concentrations of Ba, Pb, Sr, and Zn than do surficial sediments within 180-m of well jacket (control) 288-5, the probable sources being a combination of drilling muds, produced formation waters, and corrosion of the drilling structures.

15. Produced water discharged from the two production platforms in BOF were found to contain significant concentrations of only two trace metals, Sr and Ba.

WORK UNIT 2.3.4 - CONDUCT BIOASSAYS OF OIL FIELD DISCHARGES TO DETERMINE TOXICITY AND OTHER EFFECTS IN PENAEID SHRIMP

NMFS/SEFC Galveston Laboratory

Z. P. Zein-Eldin
P. M. Keney

OBJECTIVES

1. Determine the 96-hour survival of penaeid shrimp exposed to varying concentrations of Buccaneer Oil Field (BOF) effluents.

2. Determine whether there were differences in response to effluent with seasons, with size of test animal, or with species of test animal.

3. Attempt to demonstrate long-term effects of effluents upon penaeids.

MATERIALS AND METHODS

1. Static bioassays conducted according to general methods outlined by EPA (1976).

2. Experimental animals hatched in the laboratory and maintained at salinities of 25-33°/oo and temperatures of 23-26°C.

3. Toxicity test concentrations of produced brine effluent ranged from 1,000 to 50,000 ppm (volume brine/volume diluent).

4. Oxygen concentrations monitored daily in test tanks of surviving shrimp only. Data reflecting erroneous values due to microbial activity were eliminated.

RESULTS AND CONCLUSIONS

1. Critical produced brine effluent concentrations for the 1977 collections fell between 5,000 and 10,000 ppm (excepting October), and were between 1,000 and 5,000 ppm for the two samples collected in 1978.

2. Biocides were not added to the produced brine at the production platform in October 1977.

3. Oxygen concentration measurements indicated that there was a significant difference in daily oxygen consumption with time of exposure ($P \leq 0.01$).

4. Shrimp given produced brine effluent-soaked feed survived and grew the same as animals given feed soaked in natural sea water.

5. Apparent differences in molting occurred among the groups tested.

6. Survival following molting was greatest for 1 to 2 animals per test container.

7. Individual rather than groups of animals should be used per container and such containers replicated in experiments of juvenile brine toxicity to penaeids (<25 mm total length).

8. Toxicity of the brine effluent differed depending on when collections were made and how long it had been stored.

9. Suspended material should be separated by either centrifugation or filtration, resuspending it at known concentrations in natural seawater for toxicity comparisons against both supernatant fluid alone and whole effluent.

10. LD_{50}'s for penaeid shrimp exposed to dilutions of discharge brine were much higher than those reported using various crude oil dilutions.

11. Long-term tests suggested that exposure to ingested brine effluents may well predispose penaeids to stress in an acute exposure.

WORK UNIT 2.3.5 - DETERMINE EFFECTS OF OIL FIELD DISCHARGES ON SPECIES COMPOSITION AND ABUNDANCE OF FISHES AND DEMERSAL FISHES AND MACRO-CRUSTACEANS IN THE OIL FIELD

PART A

NMFS Galveston Laboratory

I. K. Workman
C. E. Jones

PART B

Landry and Harper Consulting Service

A. M. Landry, Ph.D.
D. E. Harper, Ph.D.

PART C

LGL, Ecological Research Associates

F. J. Margraf, Ph.D.

OBJECTIVES

PART A

1. Determine seasonal distribution patterns and rates of produced brine effluent discharge from an oil and gas production platform.

2. Determine effects of produced brine effluent discharge on fish species associated with production platform.

3. Determine species composition, abundance, and distribution of fishes and macro-crustaceans under and around oil and gas field structures with and without effluent discharges.

4. Determine feeding habits of fishes associated with an oil and gas field.

5. Determine areal movement of fishes among structures in an oil and gas field.

PART B

1. Determine food habits of selected demersal and pelagic fishes occurring in the Buccaneer Oil Field (BOF).

2. Verify species identification of all BOF finfish and macro-crustacean reference specimens obtained under Part A.

PART C

1. Compare collections in BOF with collections at "control" sites outside BOF, and compare collections near production platforms with collections near well jackets.

2. Summarize data tabularly or in figure form emphasizing areal and temporal distributions.

3. Conduct analyses of morphometric characteristics, stomach contents, and sex composition for selected species .

MATERIALS AND METHODS

PART A

1. Dye dispersion studies employed to determine rates of produced brine discharge and dispersal patterns beneath production platforms 288-A and 296-B.

2. Field bioassay of produced brine were conducted on production platforms 288-A and 296-B using caged blennies (two species) collected from oil and gas field structures without discharges.

3. Underwater time-lapse photography was used to assess species composition and relative abundance of fishes in relation to type of structure (production platform or well jacket) and water depth.

4. A modified sablefish trap (Hipkins, 1974) was used to obtain reference specimens and additional information on species composition and vertical distribution under two structure types (production platform and well jacket).

5. Visual censuses of reef fishes (in close association with structure members) and macro-crustaceans taken by divers using SCUBA.

6. An airlift suction sampler (slurp gun) was employed during winter samping to collect specimens for determination of species composition, abundance, and vertical distribution of blennies (most abundant reef fishes) for production platform 296-B and well jacket 288-5 (control).

7. Demersal fishes and macro-crustaceans were collected around production platforms 288-A and 296-B, and well jacket 296-1 using a 6.1-m trawl towed for 5 minutes along the side of and as close as possible to structures.

8. Selective collections of specimens were made by spear, slurp gun, and hook-and-line, and records were kept of visual observations by divers in the field. These contributed to confirmation of species identification, incidences of diseased organisms, feeding habits, general condition, and areal movements of fishes under and around structures associated with the oil field.

9. Tagging was used to determine movements among oil field structures and residence times for selected fish species (snapper, grouper, and bluefish).

PART B

10. Stomachs contents were determined for 20 species of finfish.

11. Fishes were identified to species, measured for fork length and total length, wet-weighed to the nearest 0.1 g, and sex was determined by gross inspection of gonads.

12. Fish stomachs and intestines were removed, labeled for identification, injected with buffered 10% formalin, wrapped in cheesecloth, and stored in 10% formalin until stomach contents identification and enumeration were performed.

PART C

13. Trawl data for 1976-77 and 1977-78 studies were subjected to cluster analysis.

14. Trap (1976-77), and hook-and-line, longline, and gill net collections were summarized tabularly, including numerical abundance and biomass observations.

15. SCUBA diver visual observations and time-lapse camera census information were summarized. Number per square meter and number per cubic meter were estimated.

16. Fish stomach contents data were summarized by station and by season. Percent of stomachs examined which contained a particular food item was determined.

RESULTS AND CONCLUSIONS

PART A

1. Dye studies indicated that produced brine discharge penetration was relatively shallow (10- to 12-m average penetration, 3- to 6-m maximum concentration).

2. Dispersal of produced brine discharge beneath production platforms 288-A and 296-B, was a function of current velocity and direction.

3. Produced brine discharge with added biocides had adverse effects on the encrusting organisms and small reef fishes inhabiting the shallow structure members of the two production platforms.

4. Pelagic/Nektonic and demersal fishes and macro-crustaceans did not appear to be directly affected by the produced brine discharge.

5. Red snapper was determined to be a structure-faithful fish around the oil field structures.

6. Stomach contents suggest that some of the fishes found under the oil field structures derive some of their food by grazing on the plant life attached to oil field structures.

7. Longlines fished during summer 1976 collected mostly sharks.

8. Diver visual census estimates of animal density, (numbers of animals per square meter of structure surface) ranged from less than $1.0/m^2$ for belted sandfish to over $50.0/m^2$ for blennies.

9. Average densities (numbers of animals per cubic meter of water) of pelagic fishes observed by underwater camera ranged from less than $0.001/m^3$ to almost $0.25/m^3$.

PART B

10. Total of 39 species of macro-invertebrates and 38 species of finfish were trawled from the BOF during October 1977 and March 1978.

PART C

11. A total of 92 finfish species and 54 macro-invertebrate species were identified from BOF from 1976-1978.

12. Cluster analysis techniques applied to 1976-77 trawl collections resulted in four distinct clusters; (a) spring collections, (b) fall and winter collections, (c) two collections of too few organisms to determine association, and (d) summer collections. Seasonal influences were predominant over areal distributions of organisms.

13. Cluster analysis techniques applied to 1977-78 trawl collections resulted in two distinct clusters; (a) primarily fall collections with one winter collection included, and (b) winter collections. Seasonal influences were predominant over areal distribution of organisms in determining clusters.

14. Analysis of covariance applied to length-weight relationships of blennies collected by airlift from production platform 296-B and well jacket 288-5 (control) during 1977-78 indicated no significant differences.

WORK UNIT 2.3.6 - DETERMINE THE EFFECTS OF DISCHARGES ON SEASONAL ABUNDANCE, DISTRIBUTION, AND COMPOSITION OF ICHTHYOPLANKTON IN THE OIL FIELD

NMFS/SEFC Panama City Laboratory

J. H. Finucane
L. A. Collins
L. E. Barger

OBJECTIVES

1. Determine whether presence of brine discharge and other contaminants from production platforms affects abundance, occurrence and distribution of fish eggs and larvae.

2. Determine seasonal abundance, occurrence, distribution and species composition of ichthyoplankton in oil field and adjacent control areas.

3. Determine times and places of spawning for selected taxa by examination of eggs and larvae.

MATERIALS AND METHODS

1. Collections made with bongo net tows using standard MARMAP (Marine Resource Monitoring, Assessment and Prediction) sampling gear and techniques.

2. Bongo tows performed approximately 30 m from sides of platforms 288-A, 296-B and satellite structures. Four tows taken at each structure.

3. Tows designed to sample depth strata equally from surface to near bottom.

4. Plankton samples transferred to jars containing 7% buffered formalin in seawater.

5. Plankton displacement volumes determined by Yentsch plankton volume gauge after removing large ctenophores, sargassum, and detrital material.

6. Ichthyoplankton samples sorted to lowest possible taxon by examining the entire sample (no aliquots taken).

7. Fish larvae measured to nearest 0.1 mm or nearest 1.0 mm when over 10 mm in size (total length).

8. Water temperatures determined using expendable temperature-sensing bathythermographs (XBT) during first cruise. Surface temperatures determined on each cruise by bucket collection and thermometers graduated to 0.1°C.

9. Salinities determined each cruise by Goldberg refractometer method.

RESULTS AND CONCLUSIONS

1. 39 families, 59 genera and 40 species of pelagic fish larvae were identified.

2. Engraulids, sciaenids, and bothids were the three most abundant taxon.

3. Seasonal sampling showed that the highest abundance of larvae (59%) and eggs (66%) occurred in July and the lowest abundance of larvae (4%) and eggs (6%) occurred in February.

4. Species diversity was greatest around the production platforms in July and October. Species diversity was greatest around satellite structures in February.

5. Highest larvae abundance occurred at the satellite structures followed by the production platforms and the outside control stations.

6. Total egg abundance was highest in July at the platforms and highest in October and February at satellite structures.

7. Egg and larval numbers are similar when BOF oil field sampling stations are compared with BLM STOCS sampling stations of equal depths on a seasonal basis.

8. Buccaneer Oil Field is a major spawning ground for anguilliformes, callionymids, clupeids, engraulids, sciaenids, scombrids, and soleids based on egg abundance.

9. Spawning times and intensity varied on a seasonal basis.

10. Data did not show that the brine discharge and other possible contaminants from the platforms adversely affected the ichthyoplankton abundance, occurrence or distribution in the oil field.

WORK UNIT 2.3.7 - DETERMINE AND COMPARE GROUPS OF BACTERIA FROM AN ACTIVE OIL FIELD AND UNALTERED AREA

University of Houston

R. K. Sizemore, Ph.D.
S. J. Hollaway
G. M. Faw

OBJECTIVES

1. Estimate the number of various types of bacteria in the oil field as compared to a control site.

2. Determine the taxonomic makeup of bacterial communities in the oilfield and the control site.

3. Examine the effects of Buccaneer Oil Field effluents on bacterial growth, chemotaxis, and attachment.

4. Estimate the bacterial degradation potential for Buccaneer Oilfield (BOF) hydrocarbons.

MATERIALS AND METHODS

1. Samples were collected at seven sites on four seasonal cruises and one intensive sampling effort around Platform 288-A.

2. All samples were plated in the field immediately after collection.

3. Total viable counts (TVC) were determined using a spread plate technique and modified salt water yeast extract (MSWYE) agar.

4. Platings were replicated at a minimum in triplicate and counts were presented as arithmetic averages of the replicates.

5. Plates were incubated at 25°C and were counted after 2 and 7 days.

6. Strains selected for taxonomic analysis were collected directly from the TVC field plates.

7. Biomass estimates were calculated by multiplying the total viable counts by the average cell volumes estimated from submerged slide experiments.

8. Submerged slide experiments were conducted using chromic acid cleaned glass cover slips submerged at each sampling site from 2 to 24 hours, rinsed at time of retrieval with sterile salts solution, returned to the laboratory, and fixed and stained before microscopic examination.

9. Oil- and sulfur-utilizing bacteria were enumerated in triplicate using most probable number (MPN) extinction dilution technique.

10. Bacteria attached to suspended particulate material were enumerated by selective filtration followed by spread plate counts on MSWYE agar.

11. During the fall cruise, water samples were enumerated for the presence of bacteria resistant to heavy metals by plating samples onto MSWYE agar plates prepared with appropriate concentrations (100 ppm) of the heavy metals in the media.

12. Anaerobic sulfur metabolism was examined during the intensive sampling period by using Kliger iron agar plates prepared with three-salts solution and examining the incubated plates for hydrogen sulfide production.

13. Toxicity of sterile BOF condensate and sterile produced brine discharge to mixed and pure bacterial cultures (BOF-derived cultures and laboratory reference strains) was tested by incubating inoculated preparations while shaking at room temperature for various time intervals and enumerating at termination using either total viable counts or spectrophotometry.

14. Bacterial chemotactic responses were tested in the presence of BOF hydrocarbon products by filling capillary pipets with sterile solutions of suspected attractants or repellents and subjecting the pipets to various bacterial solutions, enumerating bacterial migration toward or away from the tested products at termination.

15. Ability of bacteria to attach to glass surfaces was measured in the presence or absence of BOF hydrocarbons by submerging acid-cleaned glass cover slips in diluted bacterial cultures containing three-salts solution with or without diluted BOF condensate or BOF produced brine discharge and enumerating attachment at termination by direct microscopic examination and counting.

16. A standard marine taxonometric dichotomous key was used to classify all BOF bacterial isolates to the generic level.

17. Potential for bacterial degradation of BOF produced brine discharge hydrocarbons was assessed by comparing utilization of specific hydrocarbon components in growth flasks containing various mixed and pure cultures from BOF and laboratory reference strains against uninoculated (abiotic weathering control) preparations, utilizing liquid column chromatography for fractionation of BOF crude oil (by polarity) and gas chromatography for qualitative and quantitative determination of hydrocarbons.

18. The saturated (non-polar) fraction, containing the alkane homologous series, was stressed in all degradation experiments because this fraction represents the greater portion of BOF-derived hydrocarbons.

RESULTS AND CONCLUSIONS

1. More oil-degrading and sulfur-oxidizing bacteria were found near production Platform 288-A than in the control area.

2. Pseudomonas was the most common bacterial genus in both the oilfield and the control site.

3. Other genera found included Vibrio, Aeromonas, Moraxella, and Acinetobacter.

4. There was no noticeable difference in generic composition of bacteria found at different sampling sites.

5. In general, diluted BOF produced brine discharge did not adversely affect bacteria.

6. Bacterial chemotaxis in certain test strains was affected by BOF produced brine discharge.

7. Some strains appeared to be attracted toward BOF produced brine while others either were repelled or exhibited reduced chemotaxis in the presence of the brine.

8. Under laboratory conditions, mixed culture inocula showed little, if any, hydrocarbon degradation.

9. Certain pure cultures were isolated which could readily attack the "alkane" fraction.

10. One strain (a Pseudomonad) was able to utilize approximately 50% of the alkanes in a 7-day period which, combined with the abiotic weathering, resulted in a net loss of about 80% of the alkane fraction in 7 days.

WORK UNIT 2.3.8 - DETERMINE EFFECTS OF OIL FIELD STRUCTURES AND DISCHARGES ON MARINE COMMUNITY COMPOSITION AND PRODUCTION

LGL, Ecological Research Associates

B. J. Gallaway, Ph.D.
M. F. Johnson, Ph.D.
R. L. Howard
L. R. Martin
R. S. Boland

OBJECTIVES

A. Routine Sampling Program

1. Compare biomass and diversity of fouling community on different structures in terms of depth and proximity to brine discharge based upon scraping samples.

2. Compare seasonal recolonization rates of biofouling community at near-surface depths under the brine discharge pipe to an area on a satellite well without a discharge.

3. Using above data, estimate differences in net production rates of the biofouling community in discharge-affected and non-affected areas.

B. Experimental Program

1. Define population levels and infield movements of Atlantic spadefish, Chaetodipterus faber.

2. Determine food, feeding rates, feeding periodicity and condition of Atlantic spadefish.

3. Determine feeding rates and periodicity of the dominant fouling organism, the barnacle, Balanus tintinnabulum.

4. Evaluate effects of produced brine discharge on uptake rates of dissolved oxygen using respirometry techniques.

MATERIALS AND METHODS

1. Scraped samples of fouling community collected seasonally by divers using SCUBA.

2. Samples collected from five different structures in BOF for contrasts between structures with produced brine sewage, and heated water effluent discharges to control structures without such discharges.

3. Samples collected by scraping and preserved in 10% formalin.

4. Total weight, shell weight, percent coverage of each major group, species composition of cryptic species, numbers of individuals of each cryptic species, and net weight biomass of each cryptic species determined for each scraping sample.

5. Count and weight data for respective taxa were summarized using Shannon-Weaver diversity index.

6. Differences between stations for samples of biofouling organisms, species diversity, evenness, and species richness data tested by analysis of variance techniques.

7. Cluster analysis techniques used to explore associations between collecting sites and species (taxa) associations.

8. Effect of produced water discharge on recolonization rates and community composition of the biofouling community measured by collecting "new" growth of fouling organisms at varying time intervals.

9. Production rates of biofouling community calculated on seasonal changes in standing stock biomass.

10. Mark and recapture studies for Atlantic spadefish in August 1977, and February-March 1978.

11. Mark and recapture study samples collected August 1977 by hook-and-line, measured for standard length, tagged, and released at the platform of capture.

12. Mark and recapture samples marked *in situ* February-March 1978, using lances equipped with detachable barbed tags.

13. Summer population estimates using single census method expressed by Bailey's modification (1951) of Petersen formula: $N = \frac{M(C+1)}{R+1}$

14. Spadefish captured in Winter 1977 by spear at different platforms and times of day, measured, sexed, stomachs removed, preserved in formalin, and analyzed for food habits and feeding periodicity.

15. Excised spadefish stomachs dissected and major taxa of food organisms identified by species and percent weight of total.

16. Fullness index used to compare spadefish feeding behavior.

17. Length-weight relationships for spadefish compared by analysis of covariance techniques.

18. Estimates of barnacle feeding rates derived from literature review.

19. Barnacle feeding periodicity determined by diver observation.

20. Respirometry studies of fouling community conducted using 45-cm inside diameter acrylic plastic dome (fitted onto a wooden base) containing a Hydrolab Model 8002 dissolved oxygen probe and stirrer.

RESULTS AND CONCLUSIONS

1. Produced brine discharge had adverse effects on the fouling community directly under the discharge pipe. Adverse effects included lower densities and biomass of most fouling organisms, lower survival rates of barnacles, lower rates of production and lower rates of recolonization than in areas not proximate to the discharge.

2. Cluster analysis indicated that community structure in the area beneath the produced brine water discharge differed greatly from community structure observed in other areas.

3. Warm water sewage discharge appeared to stimulate growth and production of near surface biofouling communities.

4. Biomass of the fouling community was considerably higher in winter than in summer.

5. Highest rates of recolonization of microcryptic forms occurred during the summer to winter period.

6. Gross seasonal production of the fouling community was greatest for the summer to winter period.

7. Population size of Atlantic spadefish was correlated with oilfield structure size.

8. Atlantic spadefish appeared "habitat faithful" to the oil field structures.

9. Spadefish are dependent upon plankton and suspended particulate matter for food.

10. Spadefish populations in the Buccaneer Oil Field suffered a disease epidemic during winter.

11. Barnacles feed mainly at night.

12. Produced brine greatly increased oxygen consumption rates in the fouling community when introduced into an *in situ* respirometer. The size of the area impacted was not determined.

WORK UNIT 2.3.9 - DESCRIBE SEASONAL CIRCULATION PATTERNS IN THE OIL FIELD

NMFS Atlantic Environmental Group
Narragansett Laboratory

R. Armstrong

OBJECTIVES

1. Define the annual circulation patterns and forces governing the currents.

2. Describe dispersion characteristics of the waters.

3. Develop information for predictive modeling of concentration and movement of potential contaminants.

4. Provide physical oceanographic interpretations supportive of other projects.

MATERIALS AND METHODS

1. Three seasonal dye experiments conducted based on recommendations offered by Okubo (1971).

2. Ten gallons of water soluble Rhodamine WT Liquid Dye (20% aqueous solution, E. I. Du Pont de Nemours and Co., Inc.) released on water surface from shipboard in each dye study.

3. Vertical penetration and horizontal concentration of the Rhodamine dye measured on shipboard using a strip-chart recorder and a Turner Assoc. Model III fluorometer with continuous flow arrangement connected to a submersible pump at the end of a 500-ft garden hose.

4. Temperature measured using a Sippican expendable bathythermograph (XBT) system and T-10 EBT probes (0- to 200-m depth range).

5. Salinity measurements determined by hand refractometer and titration.

6. Wind speed and direction measured using a hand-held anemometer.

7. Smoke bombs released during each experiment and recorded in aerial photographs against the backdrop of the dye plumes.

8. Dimensions of the dye plume calculated from aerial photographs using the vessel for scaling perspective.

9. Movements of the dye plumes determined by Radar fixes from aboard ship off Platform 288-A.

10. Drift bottles and transponding buoys deployed and tracked by NMFS during the first year of the Buccaneer Oil Field (BOF) studies.

11. Transponding buoys deployed and tracked with dye studies.

12. Data from current meter and wind observations recorded from instruments (at Platform 288-A) furnished by Shell Development Co., Exxon Production Research Co., AMOCO Production Co., Mobil Research and Development Corp., and Chevron Oil Field Research Co.

13. Wind records of daily prevailing direction and average speed at Galveston acquired from the Galveston station of National Weather Service and were used to examine correspondence between winds and the movements of transponding buoys.

14. Data for tidal currents taken from National Ocean Survey predictions of tidal currents for Galveston Bay entrance (U.S. Dept. of Commerce).

RESULTS AND CONCLUSIONS

1. Dye studies indicated rates of dispersion of dissolved and suspended materials are controlled by winds, currents and tides.

2. Dye plumes grew more rapidly downwind with the current trajectory. Growth rates were highly dependent on vertical shear of horizontal flow.

3. Currents were aligned principally in alongshore directions reversing seasonally from upcoast toward the northeast in summer (May-August) to downcoast toward southwest for October-April.

4. Buoy movements indicated no vertical structure to the currents. Conversely, current meter records showed periods of layering of contrasting flows during summer.

5. Local winds were main driving force for circulation patterns; flow typically with the wind, deflected by the coastline and with compensating offshore transport with onshore winds, or to the right of the winds as with Ekman transport.

6. Distinct departures from local wind-driven circulation developed during spring, when high river discharge seemingly established a downcoast, geostrophic current which, from current meter records, may have accounted for the layered currents of summer.

7. Early fall currents did not seem to relate to local winds, but may have been responding to larger scale atmospheric alterations.

8. Spectral analysis of current meter records indicated that tidal currents and wind shifts accounted for most of the variability in flow dynamics, with dominant periods perhaps associated with passage of continental air masses in winter and fall and longer maritime air mass development during summer.

Task 2.4

Determine the Specific Pollutants, Their Quantity, and Effects on the Various Components of the Marine Ecosystem.

WORK UNIT 2.4.1 - DETERMINE LEVELS, PATHWAYS, AND BIOACCUMULATION OF SELECTED DISCHARGE CONSTITUENTS (NON-METALS) IN THE MARINE ECOSYSTEM IN THE OIL FIELD/HYDROCARBON MODELING

PART A

University of Houston

B. S. Middleditch, Ph.D.
B. Basile

PART B

University of Houston

B. S. Middleditch, Ph.D.
B. Basile
S. R. Missler

OBJECTIVES

PART A

1. Survey the hydrocarbon content of water, sediment, and biota in the Buccaneer Oil Field (BOF).

2. Monitor discharges emanating from production platforms 288-A and 296-B for constituents and quantities.

PART B

3. Evaluate the hydrocarbon data from the first 2 years' studies and incorporate these data into the construction of a model which would account for the various sources, distributions, fates, and effects of hydrocarbons in the vicinity of Buccaneer Oil Field.

MATERIALS AND METHODS

PART A

1. All samples were frozen immediatley upon collection and maintained at -20°C until processing.

2. Discharged brine samples were collected in 250-ml or 1.0 l wide-mouth glass bottles fitted with ground glass stoppers.

3. Bottom water samples were collected by Nansen bottles or by divers (SCUBA) using 1.0 l bottles.

4. Surface water samples were collected by Nansen bottle, stainless steel bucket, or glass bottles from bow of ZODIAC rubber boat to minimize contamination.

5. Samples for platform studies were collected using a Brinkmann sampler equipped with 1.0 l Wheaton bottles fitted with teflon-lined screw caps.

6. Subsurface plankton samples were obtained using paired 61 cm diameter bongo nets with mesh sizes of 0.333 and 0.505 mm.

7. Surface plankton samples were collected with neuston nets having a mouth opening of 0.5 by 1.0 m and mesh size of 0.505 mm.

8. Fish samples were collected by trawling with a 12 m untreated nylon mesh semiballoon shrimp trawl, by trapping with modified sablefish traps, and spearing by SCUBA divers.

9. Shrimp samples were collected with a 12 m nylon mesh semiballoon shrimp trawl.

10. Benthic samples were collected by divers (SCUBA) from surface of sediments.

11. Barnacle samples were collected by divers (SCUBA).

12. Sediment samples collected during 1976 were obtained with a 15 cm coring device or ponar grab.

13. Additional sediment samples collected during 1977 were scooped directly into 250 ml glass jars by divers (SCUBA).

14. Bacteria samples were supplied by Dr. R. K. Sizemore (Work Unit 2.3.7) in solvent-rinsed scintillation vials from cultures of sediments in the vicinity of the production platforms.

15. Oil and gas condensate samples were collected in 250 ml bottles fitted with ground glass stoppers.

16. Vessel fuel was collected from the Research Vessel GUS III.

17. Biocide, surfactant, skim tank oil and brine separator drip pan water samples were obtained from production platforms 288-A and 296-B.

18. One sample of sewage discharge pipe water from the living quarters platform (288-A) was obtained and analyzed.

19. Four gallons of discharged brine were collected from production platform 296-B in 1.0 gallon solvent bottles for bulk analysis.

20. Discharged brine and seawater samples were processed for GC-MS analysis by acidifying to pH 2.0, adding internal standards, shaking in a separatory funnel (1976-77) or tumbling on a modified rock polisher for 24 hr (1977-78), and concentrated using a Buchi/Brinkmann Rotavapor R rotating evaporator before column chromatography.

21. Plankton samples were processed by adding internal standards to 10.0 g of plankton, homogenizing with a Brinkmann PT10-35 polytron power unit equipped with a PT 20ST generator, saponifing at 110°C for 2 hr, extracting with diethyl ether, drying over anhydrous sodium sulfate, and concentrating using the rotating evaporator.

22. Thirty-one species of large fish were processed by excising a sample of dorsal flesh and liver using degreased scalpel and scissors.

23. Seven species of smaller fish were analyzed for flesh hydrocarbons only (no livers).

24. Whole body analysis was performed on crested blennies and seaweed blennies.

25. Processing procedures for fish, shrimp, benthos and barnacle flesh samples were the same as for plankton. The weight of each sample analyzed varied as follows: Fish (10-20 g flesh, 2-5 g liver); shrimp (5-20 g flesh); benthic (2-20 g flesh); barnacle (15-35 g flesh).

26. Barnacle shell samples (no flesh) obtained during June 1976-May 1977, were processed by placing 50-100 g of shell in 45- x 130-mm glass extraction thimbles, internal standards added, extracted with 300 ml of cyclohexane for 6 hr in modified Soxhlet apparatus, then reduced in volume prior to column chromatography.

27. Barnacle shell samples (no flesh) collected after June 1977, were extracted by tumbling with 100-ml cyclohexane in 1.0-liter glass bottles fitted with teflon-lined screw caps for 24 hr on a modified rock polisher. Extracts were reduced in volume prior to column chromatography.

28. One-hundred grams of 1976 sediment samples were freeze-dried, internal standards added, and extracted for 6 hr with 300 ml of cyclohexane in a modified Soxhlet apparatus. Extracts were concentrated prior to liquid chromatography.

29. 1977-1978 sediment sample analysis procedures were the same as described in item no. 27.

30. Bacteria samples were suspended in 5.0 ml of deionized water, internal standards added, sonicated using heat systems ultrasonics probe until viscous, homogenate transferred to 50-ml centrifuge tube, and extracted as described in item no. 21.

31. Oil, condensate, vessel fuel, surfactant, and biocides, skim tank oil samples were processed by placing 10 ml (approximately 1.0 mg) of sample and 10 ml of standards in 1.0 ml of cyclohexane. This solution was then used for column chromatography.

32. Brine separator drip pan and sewage discharge pipe water samples were processed using the same procedure as item no. 20.

33. Bulk discharged brine samples were processed by shaking 250 ml cyclohexane in the sample bottle; transferring aqueous phase to a 2nd bottle; rinsing the sample bottle twice with 125 ml cyclohexane; re-extracting the contents of the 2nd bottle with 250 ml of bottle wash cyclohexane; combining the organic phases; allowing sulfur to settle out (and saved); and concentrating the organic phase prior to column chromatography.

34. All organic solvents (except diethyl ether) were Mallinckrodt (St. Louis, Mo.) "Nanograde" quality.

35. Diethyl ether was Mallinckrodt "Reagent Grade" quality.

36. Column chromatographic fractionation of samples was achieved using a 1- x 20-cm glass column packed with activated silica gel; washed with 100 ml cyclohexane prior to sample additions; eluted with 40 ml cyclohexane ("alkanes") followed by 40 ml benzene ("aromatics"); eluants volume reduced to 1.0 ml by rotating evaporator and further evaporated under a stream of nitrogen prior to gas chromatography or combined GC-MS.

37. Column chromatography silica gel, 60-200 mesh, was obtained from J. T. Baker (Phillipsburg, N.J.) and activated by heating a minimum of 24 hr at 110°C prior to use.

38. Hydrocarbon standards were purchased from Applied Science Labs (State College, Pa.) and Chem Service (West Chester, Pa.).

39. Deuteriated hydrocarbon standards were obtained from Merck (Elmsford, N.Y.).

40. Gas chromatography (GC) was performed on Perkin-Elmer 3920 B instruments equipped with flame ionization detectors and temperature programmers.

41. Samples prior to June 1977 were analyzed by GC using silanized glass columns (2-m x 2-mm I.D.) containing 1% OV-1 packing material on 100-120 mesh supelcoport, programmed from 100-300°C at 4°C per minute.

42. Samples after June 1977 were analyzed by GC, using 30 mm glass capillary columns coated with OV-101 (packing material), programmed from 90-270°C at 2°C per minute.

43. Injector and detector temperatures were 250°C and 300°C, respectively, for all GC analyses.

44. Representative samples were examined by combined GC-MS to verify identities of compounds characterized by GC using a Hewlett-Packard 5992-A equipped with a silicone membrane separator and Silanized glass column 1-m x 2-mm I.D. containing 3% OV-17 (packing material) on 100-120 mesh gas chrom Q programmed from 90°C to 270°C at 4°C per minute.

45. Sulfur from sediment samples was quantitated by adding an appropriate quantity of sulfur-34 prior to analyses and monitoring fragment ions of sulfur via GC-MS.

PART B

46. A three-compartment hydrocarbon model for BOF was constructed and programs written in Hewlett-Packard language (HPL) for use on Hewlett-Packard 9825-A programmable calculator.

RESULTS AND CONCLUSIONS

PART A

1. Petroleum contamination of water beyond 0.2 km of the production platform could not be ascribed to Buccaneer Oil Field production activities.

2. Biota and sediments outside of the immediate vicinity of the production platforms did not contain petroleum hydrocarbons.

3. For the analysis of trace amounts of petroleum alkanes in biota, odd-even preference (OEP) values, n-heptadecane/pristane ratios, and n-octadecane/phytane ratios had low utility for the recognition of pollution and the source of petroleum.

Summary

Platform Discharges

4. Discharge of various oil production contaminants varied from 15 kg of sulfur to 523 g of oil per day. Other contaminants included inorganic ions such as sulfide and sulfate, as well as low molecular weight aromatics.

5. Benzo(a)pyrene and methylnaphthalene have been detected in most discharged brine samples.

6. Hydrocarbon content of the sewage pipe did not resemble crude oil but seemed to be composed of bacterial and fecal alkanes.

Seawater

7. Hydrocarbon distributions were influenced by wind direction rather than current direction.

8. Most surface water samples contained petroleum derived alkanes.

9. Concentrations and alkane content of seawater samples were similar to those reported by Iliffe and Calder (1974) for the eastern Gulf of Mexico and the Caribbean Sea, and those reported for other locations (Barbier et al, 1973; Brown and Huffman, 1976).

10. Alkane concentrations were greater in surface rather than bottom water samples when collected from the same location.

11. Hydrocarbon concentrations in bottom water samples were greatest downstream in the prevailing bottom current.

12. Many of the bottom water samples collected from locations more than 200 m from the production platform had a bimodal hydrocarbon distribution. Alkanes around C_{20} exhibited a distribution characteristic of petroleum alkanes, while the major components around C_{33} were apparently bacterial in origin.

13. Bottom water samples collected within 200 m of the production platforms (288-A and 296-B) contained only petroleum alkanes.

14. Half of the bottom water samples collected along transects through production platform 288-A and through well jacket 288-5 contained petroleum alkanes.

Sediments

15. The highest concentrations of alkanes were found below the centers of the platforms (14.3 ppm, platform 296-B, sample no. LXII; 21.65 ppm, platform A, sample no. LXVI).

16. Concentrations of alkanes decreased with increasing distance from the platform.

17. Odd-even carbon preference (OEP) values ranged from 0.57 to 1.07.

18. The alkanes appeared to be derived from Buccaneer crude oil.

19. n-heptadecane/pristane ratios - 0.8 to 1.25 (discharged brine ratio=1.05).

20. n-octadecane/phytane ratios - 1.0 to 3.13 (discharged brine ratio=2.44).

21. Oil in the sediments was relatively fresh, with concentration maxima between $n\text{-}C_{17}$ and $n\text{-}C_{20}$ comparable to those in discharged brine.

22. Significant amounts of oil (0.14-0.92 ppm) were in sediments 25 m from the platforms.

Barnacles

23. The alkanes concentration of barnacle shells taken near the water surface of production platform 288-A (1792 ppb) differed significantly ($P<0.0375$) from that of shells taken at well jackets 288-2, 288-3, 288-5, 288-6, 288-8, 288-10, 295-1, 296-1, 296-2, 296-3, 296-6, and 296-12 (449 ppb).

24. Hydroids and corals which reside on barnacle shells had biogenic alkane profiles which resembled a petroleum alkane profile.

25. In most samples analyzed, petroleum alkanes contributed by the discharged brine were in minor concentrations compared to the biogenic hydrocarbons.

Benthic Organisms

26. All but one of the Alcyonaria samples contained alkanes in the C_{22} to C_{32} region. While this has been used as an indicator for pollution in other samples, there was evidence that these compounds were biogenic.

27. Few of the specimens of Pteria colymbus collected at the production platform (288-A) contained petroleum alkanes, while they did contain methylnaphthalene or benzo(a)pyrene.

28. Pleuroploea gigantea had various hydrocarbon profiles which could be ascribed to petroleum contamination.

Plankton

29. The majority of surface plankton samples were contaminated with petroleum alkanes.

30. Tar balls were readily visible in two surface plankton samples.

31. Majority of subsurface samples contained only biogenic hydrocarbons, n-C_{15}, n-C_{17}, and pristane.

32. It is possible that the petroleum hydrocarbons observed in surface samples were not contained within the plankton (inside the cells), but were due to the presence of minute particles of tar.

Shrimp

33. Shrimp samples were not usually contaminated with petroleum hydrocarbons.

34. Shrimp samples contaminated with petroleum hydrocarbons were caught in areas adjacent to the production platforms.

Fish

35. Analyses of whole blennies from production platforms 288-A and 296-B demonstrated an elevated hydrocarbon level, presumably due to petroleum production activities.

36. A majority of spadefish analyzed (muscles and livers) from the production platform areas contained petroleum alkanes.

37. Muscles and livers of red snapper samples collected from the production platform areas contained petroleum alkanes.

38. Despite petroleum contamination, the dominant hydrocarbons were still the biogenic alkanes C_{17}, C_{15}, and pristane.

39. Blennies, sheepshead, spadefish and red snapper appeared to contain more biogenic hydrocarbons, either through biosynthesis or ingestion, than petroleum hydrocarbons.

40. Evidence of petroleum alkane contamination was found in the bay whiff, sand seatrout, Atlantic croaker, bluefish, Atlantic midshipman, blackfin searobin, largescale lizzardfish, longspine porgy, dusky flounder, blackcheek tonguefish, inshore lizardfish and southern hake.

41. Levels of petroleum alkanes were usually higher in livers than in muscle tissue.

PART B

42. Oil concentrations at the air/sea interface and in the water column seemed greatly influenced by current flow and, perhaps, meteorological conditions which would affect evaporation from the surface.

43. The relatively high concentrations of oil found in the sediments could be accounted for only if there was active transport of oil from the air/sea interface. It was inconceivable that solution at the surface and diffusion through the water column would be efficient enough for as much as 1.2% of the discharged oil to reach the sediment, particularly if any current were flowing through the oilfield. Possible modes of transport could include incorporation into fecal pellets (of zooplankton, barnacles, or other animals) or adsorption onto sulfur or other particulates.

44. A substantial fraction of suspended particulate matter could be redeposited in the sediment if the current flow were not excessive.

45. The environment surrounding the Buccaneer oilfield could probably tolerate a small oil spill, but long-lasting effects would result from a large spill.

Task 2.5

Develop Capabilities to Describe and Predict Fate and Effects of Oil Field Discharge Constituents in Major Components of the Marine Ecosystem.

WORK UNIT 2.5.1 - EVALUATE EXISTING ECOLOGICAL MODELS TO ADAPT AND DEVELOP A MODEL TO DESCRIBE AND PREDICT FATE AND EFFECTS OF OIL FIELD DISCHARGE CONSTITUENTS

LGL, Ecological Research Associates

B. J. Gallaway, Ph.D.
F. J. Margraf, Ph.D.

OBJECTIVES

1. Develop a mathematical simulation which will characterize the marine ecosystem of the Buccaneer Oil Field (BOF) area.

2. Identify information or data which are lacking but critical to our understanding of the system.

MATERIALS AND METHODS

1. The conceptualization of the system was determined to be best presented in the form of a compartmental model.

2. The boundary of the system was established as a 45.5-m radius of influence emanating from the center of the production platform.

3. The initial model was structured as having 17 compartments, but was reduced to 10 compartments.

4. The trophic requirements of each compartment were derived based upon assimilation efficiency (EFF) and an appropriate turnover time:

$$\text{Requirements} = \text{Standing Stock} \times \text{Turnover} \times \frac{1}{\text{EFF}}$$

5. In cases where there were no data describing preferences for one or more of an array of inputs or food sources, utilization was assumed to be on a proportionate basis among all possible sources.

6. The model is essentially particulate organic carbon (POC) based.

7. The model was parameterized for both steady state and seasonally varying conditions based upon a quarterly time step.

8. The steady state model was tested for asymptotic stability and subjected to flow analysis to determine sensitivity.

9. Flow analysis techniques followed Finn (1976) and were based upon the parameters of throughflow (Tk) and total system throughflow (TST).

10. The TST values were partitioned into a portion due to cycled throughflow (TST_c) and a portion due to straight throughflow (TST_s).

11. Path length characteristics were also determined as part of the flow analysis following Finn (1976).

12. Average path length (APL) was defined as the number of components of the system an average inflow or outflow can be expected to pass through.

13. APL was partitioned into a portion due to cycled flow (PL_c) and a portion due to straight throughflow (PL_s).

14. The cycling efficiency for each compartment was calculated as the ratio of cycled throughflow to total throughflow.

15. The results of the flow analysis outputs were used to predict where material from the platform should flow and the effects of reducing or increasing certain flows.

RESULTS AND CONCLUSIONS

1. It was concluded from the BOF production platform community model that the system is particulate-based and characterized by both a high cycling efficiency and exchange of materials with the surrounding environment.

2. The model of the system more closely resembles an estuarine ecosystem than an open marine system.

3. The system as modeled provides insights which should allow for development of mechanistic formulations controlled by external driving variables and provides project management with a framework within which to direct future research toward achieving this goal.

Task 2.2

Develop a Data Management System Applicable to Project Requirements

WORK UNIT 2.2.3 - IMPLEMENT, MONITOR, AND MODIFY THE DATA MANAGEMENT SYSTEM AS NECESSARY

National Fisheries Engineering Laboratory (NOAA)

K. Savastano
H. Holley

OBJECTIVES

1. To make the large amounts of work unit data available to users

2. To ensure an integrated project data set

3. To provide smooth flow of data products from collection to analysis, and ultimately to users

MATERIALS AND METHODS

1. Created and maintained a master file for all project data

2. Provided technical support for developing formats and log forms

3. Provided technical support for key punching and verification of project data

4. Provided technical support for data processing, verification, and quality assurance

5. Maintained data transaction and control logs

6. Provided project data to NOAA, Environmental Data and Information Service (EDIS), for archival in specified format

DATA AND ACCESSION CODES[1/]

The 1976-1978 Buccaneer Oil Field data are held by NOAA, EDIS, National Oceanographic Data Center (NODC) under Accession No: 78-0501; furthermore, each data set has been or is being converted to the appropriate "BLM/OCS" type format and given Track Numbers.

Data Set	Track Numbers		
1. Demersal Fish	TR3118	THRU	TR3121
2. Sediments	TR3122		
3. Birds	TR3123	THRU	TR3134
4. Ichthyoplankton	TR3135	THRU	TR3138
5. Pelagic Fish	TR3139	THRU	TR3151
6. Plankton	TR3152	THRU	TR3156
7. Sessile Fauna	TR3157	THRU	TR3163
8. Total Organics	TR3164	THRU	TR3167
9. Hydrocarbons	TR3168	THRU	TR3186
10. Fish Determination	TR3187		
11. Hydrography	TR3188	THRU	TR3197
12. Trace Metals	TR3198	THRU	TR3206
13. Benthos	TR3207	THRU	TR3212
14. Drift Bottles	_____[2/]	THRU	_____
15. Current Meter & Wind Records	_____	THRU	_____
16. Fish Bioassay	_____	THRU	_____
17. Brine Dye Release	_____	THRU	_____
18. Ichthyoplankton	_____	THRU	_____
19. Food Habits	_____	THRU	_____
20. Reef Fish Census	_____	THRU	_____
21. Pelagic Fish Census	_____	THRU	_____
22. Food Habits-Stomach Content	_____	THRU	_____
23. Biofouling	_____	THRU	_____

[1/] Information concerning these data files may be obtained by writing to NOAA, EDIS, NODC, Page 1 Bldg., 2001 Wisconsin Ave., NW, Washington, D.C. 20235.

[2/] To be determined.